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ABSTRACT

Statistics on computer manpower in higher education are presented. These are based upon three surveys conducted by the Southern Regional Education Board's Computer Science Project. Regarding manpower production, it is noted that there is a movement toward the use of only two names for academic programs in the area, either computer science or data processing. The number of degree programs doubled in the period from 1966-67 to 1969-70, the number of undergraduate majors enrolled tripled, and the total of graduates quadrupled. Sufficient personnel are now being trained, but programs need upgrading in both facilities and course offerings. In terms of manpower utilization, surveys show that only 50% of the faculty in departments with degree programs have doctorates and that only half of these are in computer science. Finally, the personnel required by these departments to man computer facilities rose from 14,000 to 26,000 in the three-year period covered and ancillary personnel numbered 3,000 in 1970. (PB)

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Production and utilization of computer manpower in U.S. higher education*

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SURVEYS

During the past five years the Computer Science Project of the Southern Regional Education Board (SREB) has conducted three surveys on Computers in U.S. Higher Education including their utilization and related educational programs. These studies have resulted in three publications[1,2,3] the first by the SREB and the latter two by the National Science Foundation.

The first survey was a stratified random sample of 739 institutions, from a population of 2219, selected by systematic random sampling within strata by the U.S. Office of Education. Six hundred sixty nine or 92 percent of the institutions in the sample responded.

The base year for data collection was 1964-65 and projections were requested from the institutions for 1968-69. The data collection instrument was designed by the Mathematical Sciences Section of NSF to meet their existing program needs for planning. Consequently, emphasis was placed upon the financial aspects of college and university computer center operations and only limited information was gathered with regard to manpower training and utilization.

The second survey was much more comprehensive and was sent to all institutions of higher education listed in the U.S. Office of Education's Higher Education General Information Survey (HEGIS) file. Nineteen hundred sixty five or 79 percent of the 2477 institutions responded. The data collection forms were designed with the advice and counsel of thirty or more national professional and institutional associations and government agencies. The base year for reporting data was 1966-67.

* The data upon which this paper is based was collected and processed through partial support from the National Science Foundation under contracts C465, C508 and C604. The SREB Computer Sciences Project is also supported by grants from the Esso Education Foundation and the IBM Corporation.

Extensive modifications were made in the data collection forms for the third survey. The base year was 1969 70.

Problems resulting from lack of standardization in the computer industry are well-known. Unfortunately the educational and occupational nomenclature also suffers this malady. The shifting of terms and definitions over the years can inject disastrous consequences on estimates and, particularly, projections. Attempts to make comparisons with other studies become even more hazardous. In the following only estimates and projections based upon the three surveys described above will be presented. Two other papers in these proceedings[4,5] by Gilchrist and Weber will treat comparisons and incorporate higher education's role in manpower production and utilization to give a total picture of the supply and demand for computer personnel in the U.S.

MANPOWER PRODUCTION

Educational programs in Computer Science, Data Processing, Information Science, etc., exist in institutions of higher education at all levels. Two year programs terminate with an associate degree and four year programs with a bachelor's degree. Master's and doctorate programs exist at many institutions. Although computer science and data processing are by far the most popular program names (see Table I) there appears still to be far too many different names used for educational programs in institutions of higher education. Further consolidation is necessary to ensure a healthy and unified development of the disciplines. The efforts of the ACM Curriculum Committee on Computer Science[6] and the ACM Committee on Computer Education for Management[8] have and will continue to have a unifying influence on academic programs in computer and information science. The work of these

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TABLE I—Reported Degree Programs in Computer Science, Data Processing, Information Science, etc. for Academic Years 1966-67, 1969-70, 1970-71, and 1971-72

Program Name	Associate				Bachelor's				Master's				Doctorate			
	66-67	69-70	70-71	71-72	66-67	69-70	70-71	71-72	66-67	69-70	70-71	71-72	66-67	69-70	70-71	71-72
Data Processing: Total	122	204	217	219	15	21	25	26	5	6	5	5	1	1	2	1
In Departments of:																
Data Processing		136	143	143	11	5	6	6	4	1	1	1	1	0	0	0
Business Administration	0	34	36	38	1	11	12	13	1	2	1	1	0	0	0	0
Business		17	20	20		2	2	2		2	2	2		0	1	1
Computer Science		3	3	3		1	1	1		0	0	0		0	0	0
Miscellaneous (seven)[1]	0	14	15	15	3	2	4	4	0	1	1	1	0	1	1	0
Computer Science: Total	8	33	37	42	50	90	113	133	58	76	86	102	35	50	54	59
In Departments of:																
Computer Science	7	20	23	27	30	40	52	66	35	37	39	49	22	24	25	28
Mathematics	0	0	0	0	7	19	23	26	4	8	8	9	4	3	3	3
Electrical Engineering	0	0	0	0	8	8	10	11	9	12	13	14	6	9	10	10
Computer and Information Science		1	1	1		1	3	3		3	3	3		2	2	2
Information and Computer Science		0	0	0		2	2	2		1	1	2		2	2	3
Management Science	0	2	2	3	0	6	7	8	3	0	1	2	1	0	0	0
Industrial Engineering	0	0	0	0	3	2	2	2	3	4	4	4	0	2	3	3
Miscellaneous (fourteen)	1	10	11	11	2	12	14	15	4	11	17	19	2	8	9	10
Computer Programming: Total	4	38	40	41	0	6	7	7	0	0	0	0	0	1	1	1
In Departments of:																
Data Processing		22	24	24		1	1	1			0	0		0	0	0
Computer Programming		5	5	5		0	0	0		0	0	0		0	0	0
Miscellaneous (eight)		11	11	12		5	6	6		0	0	0		1	1	1
Computer Technology: Total	8	21	22	22	1	9	9	9	0	3	4	3	0	2	2	2
In Departments of:																
Computer Technology		12	13	13	1	2	2	2		0	0	0		0	0	0
Miscellaneous (eight)[1]		9	9	9		7	7	7		3	4	3		2	2	2
Information Systems: Total	0	5	6	7	3	7	9	10	2	5	6	6	1	3	4	4
In Departments of:																
Miscellaneous (nine)		5	6	7		7	9	10	2	5	6	6		3	4	4
Information Science: Total	0	0	0	0	2	3	6	5	9	7	10	10	8	6	6	6
In Departments of:																
Miscellaneous (six)		0	0	0		3	6	5	9	7	10	10		6	6	6
Systems Engineering: Total	0	0	0	0	1	7	7	8	1	12	12	12	1	7	8	7
In Departments of:																
Systems Engineering		0	0	0	1	3	3	3	1	3	3	3	1	0	0	0
Electrical Engineering		0	0	0		2	2	3		3	3	3		3	3	3
Engineering		0	0	0		1	1	1		5	5	5		3	4	3
Industrial Engineering		0	0	0		1	1	1		1	1	1		1	1	1

TABLE I—Reported Degree Programs in Computer Science, Data Processing. Information Science, etc for Academic Years 1966-67, 1969-70, 1970-71, and 1971-72—Continued

Miscellaneous (seven):																
Total		1	1	1		5	6	8	1	5	6	6		3	5	5
In Departments of:																
Miscellaneous (ten)		1	1	1		5	6	8	1	5	6	6		3	5	5
TOTAL	142	302	323	332	72	148	182	206	78	116	137	142	46	73	82	85
Estimated Population Totals[2]	178	405	433	445	90	198	244	276	98	155	184	190	58	98	110	114

[1] ( ) Refer to 69-70, 70-71, 71-72
[2] Reported Totals x (Number Institutions in Population)/(Number Institutions Responding)

committees was supported by National Science Foundation.

Since 1966-67 the numbers of degree programs have doubled with the highest increase nearly threefold at the bachelor's level. Three out of five of the latter programs are called Computer Science and the next largest group (26) are designated as Data Processing. Twenty (20) new programs in Computer Science at the bachelor's level were expected to be started during 1971-72 and the next highest increase was expected to be at the master's level in Computer Science with sixteen new programs.

After the report[3] of the ACM Curriculum Committee for Computer Education for Management has had a chance to be circulated, I expect to see a surge in the master's level programs in Information Systems (Analysis and Design).

The numbers of majors enrolled in undergraduate programs have nearly tripled and the numbers of graduates per year have increased fourfold between 1966-67 and 1969-70 (see Table II). Figure 1 shows the growth trends at present. I do not expect significant changes in these trends for the next three to five years. After 1975 I believe that we can expect to see some

TABLE II—Reported Majors Enrolled for 1966-67 and 1969-70 and Degrees Awarded for 1966-67, 1969-70 and 1970-71

	Undergraduate								Graduate							
	No. Majors		Associate			Bachelor's			No. Majors		Master's			Doctorates		
Program Name	66-67	69-70	66-67	69-70	70-71	66-67	69-70	70-71	66-67	69-70	66-67	69-70	70-71	66-67	69-70	70-71
Data Processing	12815	27712	872	3285	3971	74	286	395	317	159	63	9	19	1	0	2
Computer Science	3187	10909	62	259	435	355	976	1537	2926	4725	446	892	1249	133	187	198
Computer Programming	281	4786	78	688	819	0	12	32	0	63	0	0	0	0	0	0
Computer Technology	496	2791	13	218	295	20	60	88	0	53	0	4	9	0	2	2
Information Systems	737	1198	0	66	94	19	91	133	31	241	6	24	43	0	1	6
Information Science	100	546	0	0	0	0	28	78	627	240	64	34	66	3	11	13
Systems Engineering	113	893	0	0	0	7	143	149	48	402	15	85	98	2	10	14
Miscellaneous (seven)	—	356	—	0	0	—	52	107	—	925	—	28	60	—	18	20
Total	17729	49191	1025	4516	5614	475	1648	2519	3949	6808	594	1076	1544	139	229	255
Estimated Population Totals[1]	22161	65916	1281	6051	7523	594	2208	3375	4936	9123	742	1442	2069	174	307	342

[1] Reported Totals x (Number Institutions in Population)/(Number Institutions Responding)

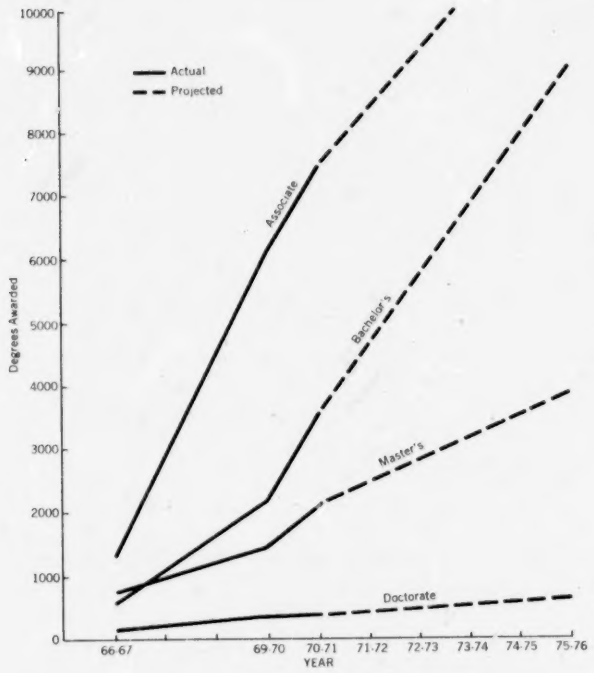

Figure 1—Degrees awarded in computer sciences, data processing, information sciences, etc. (Estimates)

leveling off at all levels. Table III shows my estimates of degrees to be awarded during the year 1974-75.

When these figures of supply are compared with estimates[4] of demand we see that there is no longer a need to encourage a crash effort to start new degree programs at any level. However, if we examine the course offerings of the associate and bachelor's degree programs, in particular, as I have had occasion to do in the two NSF Inventories,[7] there is definitely a need to strengthen these programs both in facilities available and course offerings. During 1966-67 about one out of every two programs at the associate and bachelor's degree levels were judged (by me) to be lacking in either course offerings or computer facilities.[7] Preliminary investigation of data reported for 1969-70 indicate that percentagewise there has been little, if any, improvement when advances in technology are considered.

TABLE III—Estimates of Degrees to be awarded in Computer Sciences, Data Processing, Information Science, Information Systems, etc. During 1974-75

Level	No.	To Enter Manpower Pool	Continue Education
Associate	11,000	9,000	2,000
Bachelor's	8,000	5,000	3,000
Master's	3,500	2,500	1,000
Doctorate	500	500	—
Total	23,000	17,000	6,000

TABLE IV—Estimated Manpower Utilization by Academic Departments for Programs in Computer Science, Data Processing, Information Science, etc. 1966-67

Highest Educational Level:	No.	Percent
High School Diploma	200	7
Associate Degree (2 yr.)	80	3
Bachelor's	770	27
Master's (Incl. 1st Prof.)	960	33
Doctorate	870	30
Total	2,880	100
Job Category:	**No.**	**Percent**
Faculty	2,180	76
Prof (non-Fac)	380	13
Other	320	11
Total	2,880	100

MANPOWER UTILIZATION

Computer manpower utilization in institutions of higher education fall under three broad categories. One

TABLE V—Reported Manpower Utilization by Academic Departments for Programs in Computer Science, Data Processing, Information Science, etc. 1969-70

Staff Type	Number People	Number FTE
Full-time	2,150	2,150
Part-time:		
Research Assts.	729	
Teaching Assts.	1,129	
Other	1,578	1,292
Total	5,586	3,442

	Position		
Doctorates	Faculty	Other	Total
Computer Science	345	41	386
Other	785	102	887
Total	1,130	143	1,273

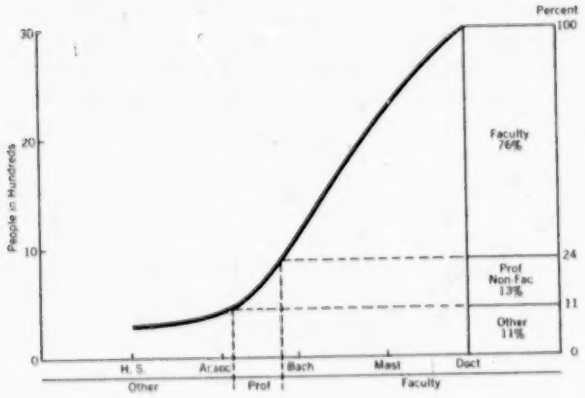

Figure 2—Estimated manpower utilization by academic departments for programs in computer sciences, data processing, information sciences, etc. 1966–67 highest level of education attained and job category

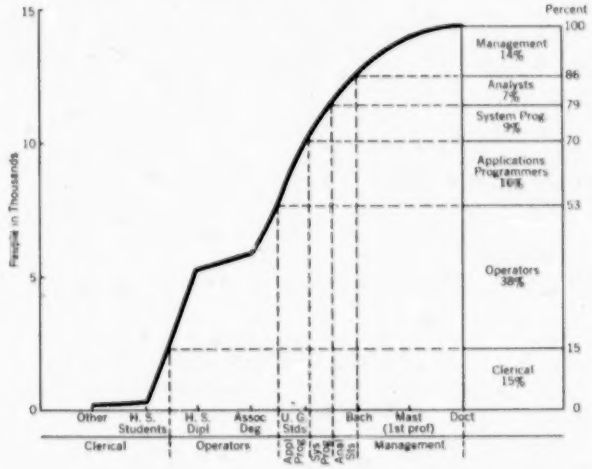

Figure 3—Estimated manpower utilization by computer centers in U. S. colleges and universities 1966–67 highest level of education attained and job classification

is the personnel of academic departments offering degree programs. For this category we have good estimates of the numbers of persons employed for 1966-67 and 1969-70 (see Tables IV and V and Figure 2). It is of interest to note that only about one out of every two faculty persons hold a doctorate and of those who do

TABLE VI—Estimated Manpower Utilization by Computer Centers in U. S. Colleges and Universities 1966-67

Highest Education Level	Estimated Total	Percent of Total
Other	210	1
High School Students	160	1
High School Diploma	4,890	34
Associate Degree	640	4
Undergraduate	3,920	27
Bachelor's	2,860	20
Master's (Incl. 1st Prof.)	1,260	9
Doctorate	570	4
Total	14,510	100

Job Classification	Estimated Total FTE	Percent of Total
Management	1,970	14
Analysts	1,040	7
Systems Programmer	1,350	9
Applications Programmer	2,360	16
Operators	5,570	39
Clerical	2,220	15
Total	14,510	100

TABLE VII—Estimated Manpower Utilization by Computer Centers in U. S. Colleges and Universities 1969-70

Highest Education Level:	Estimated Total	Percent of Total
High School Diploma	9,496	36
Associate Degree	1,360	5
Undergraduate Students	6,928	26
Bachelor's Degree:		
Computer Science	389	1
Other	5,046	19
Master's Degree:		
Computer Science	426	2
Other	2,054	8
Doctorate:		
Computer Science	174	1
Other	829	3
Total	26,704	100

Job Classification:	Estimated Total FTE	Percent of Total
Management	3,111	14
Analysts	1,820	8
Systems Programmers	2,131	9
Application Programmers	4,186	18
Operators	8,135	35
Clerical	3,725	16
Total	23,108	100

TABLE VIII—Estimates of Computer Manpower Utilized by Institutions of Higher Education in other than Computer Centers or Academic Departments Offering Degree Program in Computer Science, Data Processing, etc.
1969-70

Job Classification:	No. of People
Applications Programmers	2,000
Other	1,000
TOTAL	3,000

only about one of four have a doctorate in computer science, information science, etc. This is not surprising because the supply of doctorates in this area has been too small to fill the need. However, as the supply increases, replacements will be made from their ranks rather than from other fields.

The second category of computer manpower utilization is that of personnel required to man the computer facilities of the institutions. This includes facilities for all types of uses—research, administration and instruction. Since similar data was collected for both 1966-67 and 1969-70 some comparisons can be made or trends noticed. Table VI and Figure 3 present these data for 1966-67.

Table VII shows estimated manpower utilization for 1969-70 in the computer facilities of institutions of higher education.

The third category of computer manpower is very difficult to estimate. These are mostly applications programmers, some operators and maintenance personnel who are scattered among the various departments (both academic and administrative) and are not on a computer center payroll. My estimates of such personnel are shown in Table VIII.

SUMMARY

The numbers of degree programs, majors and degrees awarded will be of some surprise to many who are proposing to begin new programs. Of course good, solid offerings will always be desirable. However, in terms of national emphasis it is apparent that we do not need to have a national effort to create new programs. On the other hand, there is a definite need to encourage and assist with the improvement of existing programs at all levels. As a starting point the AFIPS Education Committee sponsored a meeting at the 1971 Fall Joint Computer Conference on "Accreditation: What it is, Who does it, and How it is done," for leaders of the various curriculum committees, special interest groups, and others involved with curriculum planning for Computer Science, Data Processing, Information Science, etc. This was done with the belief that we can work with the various accreditation associations to help bring about the improvements needed in these programs. Government agencies such as the Office of Computing Activities of the National Science Foundation can offer invaluable assistance by providing some of the resources required for the improvement of these programs.

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